



Fig.1

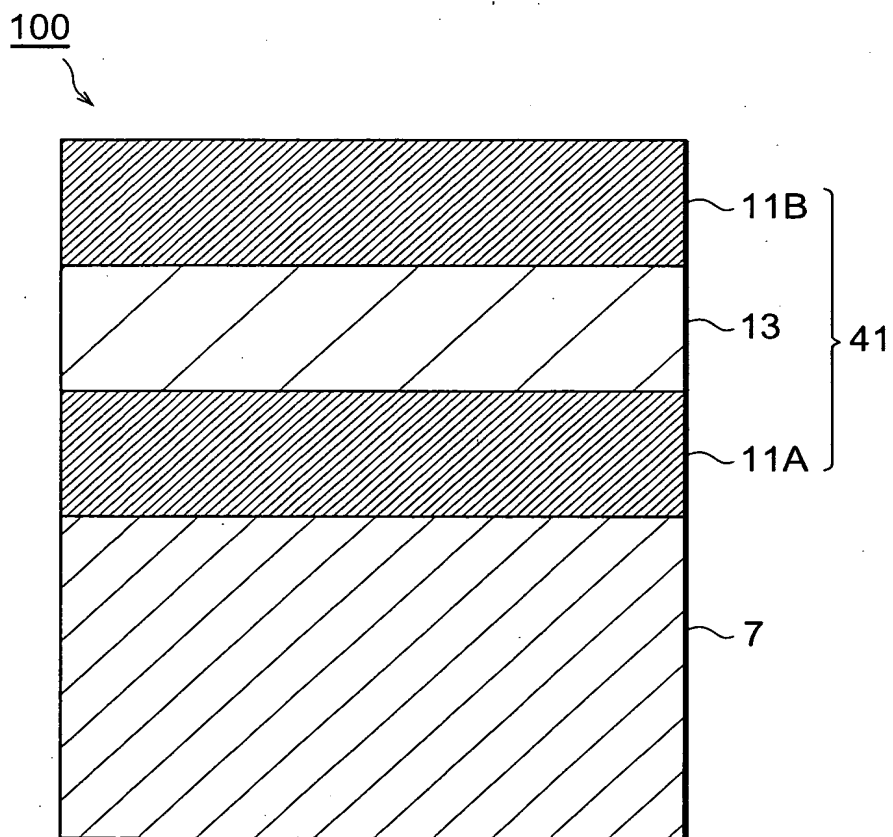


Fig.2

	FERROMAGNETIC LAYER SANDWICH			ANTIFERROMAGNETIC LAYER (THICKNESS)	Hex [kA/m]	Hcp [kA/m]	ta [nm]	Jk [$\mu\text{J}/\text{m}^2$]
	SECOND FERROMAGNETIC LAYER A (THICKNESS)	FIRST FERROMAGNETIC LAYER (THICKNESS)	SECOND FERROMAGNETIC LAYER B (THICKNESS)					
EXAMPLE1	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	IrMn (10nm)	53.7	16.2	3.34	341
EXAMPLE2	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	IrMn (9nm)	45.2	11.9	3.34	287
EXAMPLE3	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	IrMn (7nm)	50.7	14.3	3.34	322
EXAMPLE4	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	IrMn (5nm)	53.7	16.2	3.34	341
EXAMPLE5	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	RuRhMn (11nm)	36.9	9.2	3.34	234
EXAMPLE6	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	RuRhMn (9nm)	41.4	10.5	3.34	263
EXAMPLE7	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	RuRhMn (7nm)	43.8	12.4	3.34	278
EXAMPLE8	CoFe (1nm)	FeCo (2nm)	CoFe (1nm)	IrMn (5nm)	66.7	17.0	4.30	545
COMPARATIVE EXAMPLE1	—	—	CoFe (3nm)	IrMn (10nm)	26.9	3.1	3.00	153
COMPARATIVE EXAMPLE2	—	—	CoFe (3nm)	IrMn (5nm)	26.9	3.1	3.00	153
COMPARATIVE EXAMPLE3	—	—	CoFe (2nm)	IrMn (10nm)	32.7	5.9	2.00	124
COMPARATIVE EXAMPLE4	—	—	CoFe (2nm)	IrMn (5nm)	48.3	9.7	2.00	184
COMPARATIVE EXAMPLE5	CoFe (2nm)	FeTa (2nm)	—	IrMn (10nm)	18.9	8.6	3.56	128
COMPARATIVE EXAMPLE6	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	PtMn (15nm)	37.3	31.0	3.34	236
COMPARATIVE EXAMPLE7	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	PtMn (13nm)	34.3	29.5	3.34	218
COMPARATIVE EXAMPLE8	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	PtMn (10nm)	16.6	16.4	3.34	105
COMPARATIVE EXAMPLE9	—	—	CoFe (3nm)	PtMn (15nm)	64.1	32.5	3.00	365
COMPARATIVE EXAMPLE10	—	—	CoFe (3nm)	PtMn (5nm)	7.3	18.7	3.00	41.6
REFERENCE EXAMPLE1	CoFe (2nm)	FeCo (2nm)	—	IrMn (5nm)	41.6	17.4	4.30	339

Fig.3

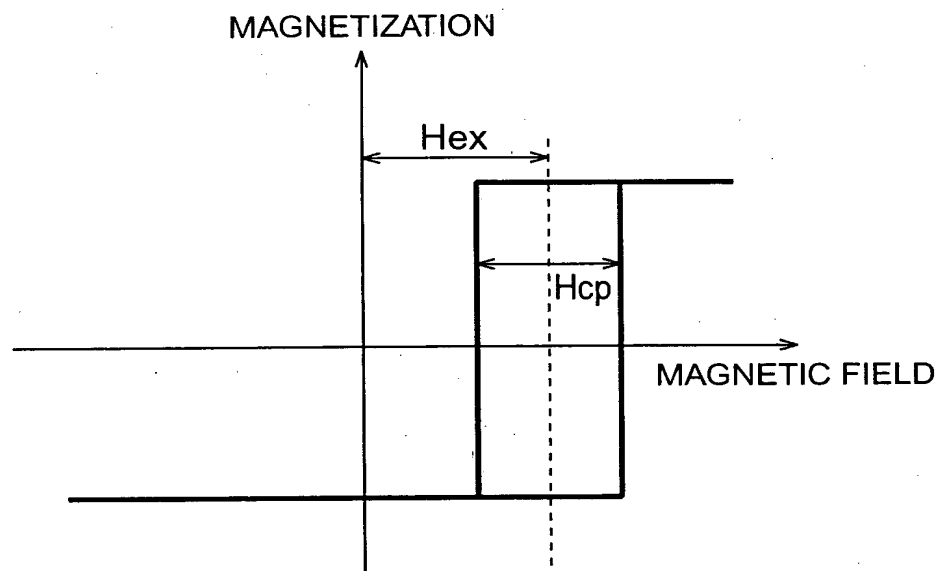


Fig.4

	FERROMAGNETIC LAYER SANDWICH			ANTIFERROMAGNETIC LAYER (THICKNESS)	Hex [kA/m]	Hcp [kA/m]	ta [nm]	Jk [$\mu\text{J}/\text{m}^2$]
	SECOND FERROMAGNETIC LAYER A (THICKNESS)	FIRST FERROMAGNETIC LAYER (THICKNESS)	SECOND FERROMAGNETIC LAYER B (THICKNESS)					
EXAMPLE1	CoFe (0.5nm)	FeTa (3nm)	CoFe (0.5nm)	IrMn (10nm)	53.7	16.2	3.34	341
EXAMPLE9	CoFe (1.5nm)	FeTa (2nm)	CoFe (0.5nm)	IrMn (10nm)	47.4	11.9	3.56	320
EXAMPLE10	CoFe (1nm)	FeTa (2nm)	CoFe (1nm)	IrMn (10nm)	57.9	13.8	3.56	392
EXAMPLE11	CoFe (0.5nm)	FeTa (2nm)	CoFe (1.5nm)	IrMn (10nm)	58.1	12.8	3.56	393
EXAMPLE12	CoFe (1.5nm)	FeTa (2nm)	CoFe (0.5nm)	IrMn (10nm)	47.4	11.9	3.56	320
EXAMPLE13	CoFe (1.5nm)	FeTa (1.5nm)	CoFe (0.5nm)	IrMn (10nm)	52.9	12.9	3.17	319
EXAMPLE14	CoFe (1.5nm)	FeTa (1nm)	CoFe (0.5nm)	IrMn (10nm)	57.6	14.2	2.78	304
EXAMPLE15	CoFe (1.5nm)	FeTa (0.5nm)	CoFe (0.5nm)	IrMn (10nm)	66.7	17.0	2.39	303

Fig.5

	FERROMAGNETIC LAYER SANDWICH			ANTIFERROMAGNETIC LAYER (THICKNESS)	Hex [kA/m]	Hcp [kA/m]	ta [nm]	Jk [$\mu\text{J}/\text{m}^2$]
	SECOND FERROMAGNETIC LAYER A (THICKNESS)	FIRST FERROMAGNETIC LAYER (THICKNESS)	SECOND FERROMAGNETIC LAYER B (THICKNESS)					
EXAMPLE8	CoFe (1nm)	FeCo (2nm)	CoFe (1nm)	IrMn (5nm)	66.7	17.0	4.30	545
EXAMPLE16	CoFe (1.5nm)	FeCo (2nm)	CoFe (0.5nm)	IrMn (5nm)	64.9	18.1	4.30	530
EXAMPLE17	CoFe (0.5nm)	FeCo (2nm)	CoFe (1.5nm)	IrMn (5nm)	65.9	16.5	4.30	538
EXAMPLE18	CoFe (1.5nm)	FeCo (2nm)	CoFe (0.5nm)	IrMn (5nm)	64.9	18.1	4.30	530
EXAMPLE19	CoFe (1.5nm)	FeCo (1.5nm)	CoFe (0.5nm)	IrMn (5nm)	71.2	18.5	3.73	504
EXAMPLE20	CoFe (1.5nm)	FeCo (1nm)	CoFe (0.5nm)	IrMn (5nm)	78.2	18.7	3.15	468
EXAMPLE21	CoFe (1.5nm)	FeCo (0.5nm)	CoFe (0.5nm)	IrMn (5nm)	61.9	13.9	2.58	303

Fig.6

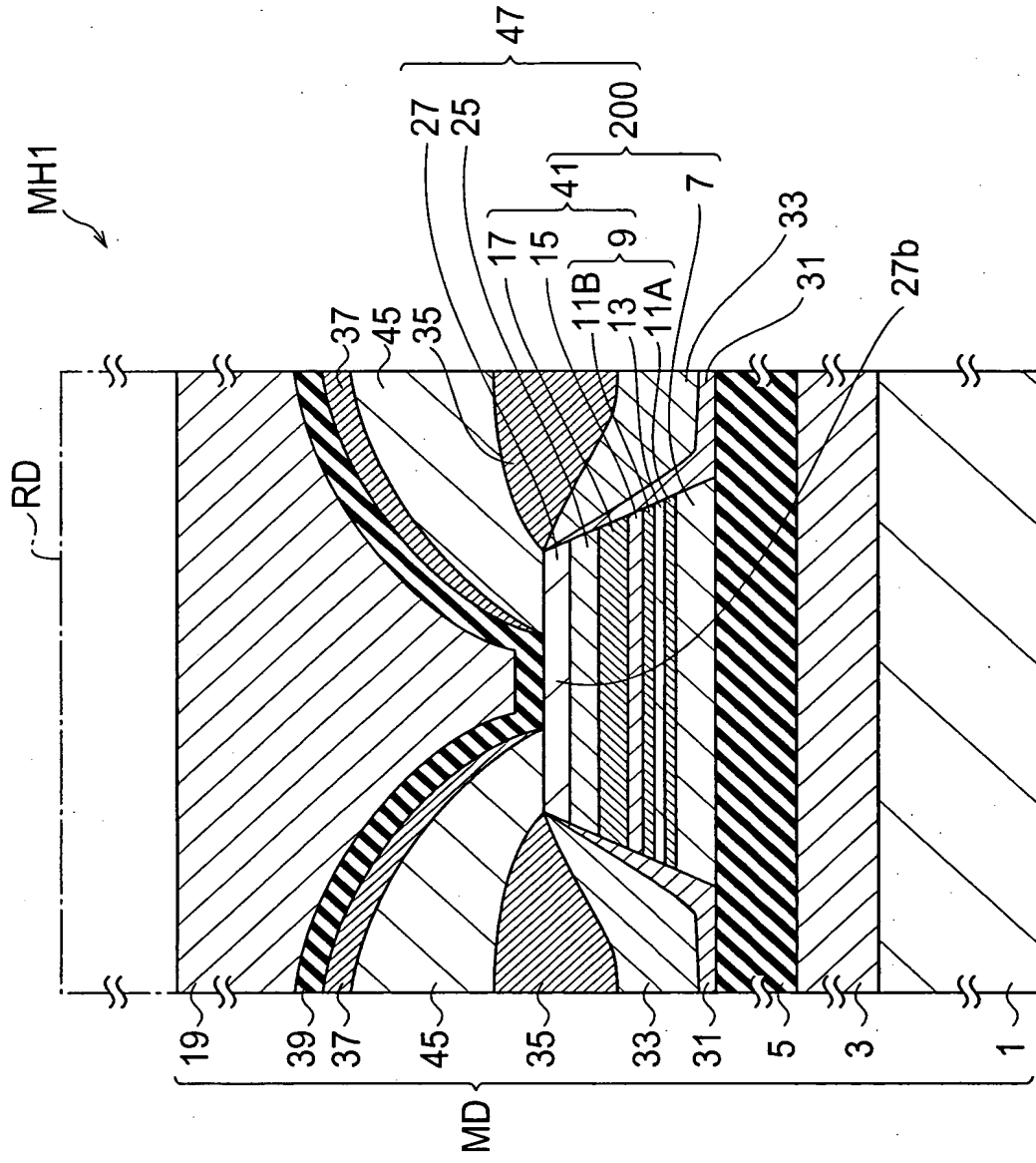


Fig.7

	ANTIFERROMAGNETIC LAYER (THICKNESS)	LAYER STRUCTURE			MR RATIO (%)	AMOUNT OF RESISTANCE CHANGE (Ω/cm^2)
		SECOND FERROMAGNETIC LAYER A (THICKNESS)	FIRST FERROMAGNETIC LAYER (THICKNESS)	SECOND FERROMAGNETIC LAYER B (THICKNESS)		
EXAMPLE22	IrMn (5nm)	CoFe (0.5nm)	FeTa (0.5nm)	CoFe (0.5nm)	16.2	3.39
EXAMPLE23	IrMn (5nm)	CoFe (0.5nm)	FeTa (0.7nm)	CoFe (0.5nm)	15.9	3.33
EXAMPLE24	IrMn (5nm)	CoFe (0.5nm)	FeTa (0.9nm)	CoFe (0.5nm)	15.8	3.27
EXAMPLE25	IrMn (5nm)	CoFe (0.5nm)	FeCo (0.5nm)	CoFe (0.5nm)	16.4	3.41
EXAMPLE26	IrMn (5nm)	CoFe (0.5nm)	FeCo (0.7nm)	CoFe (0.5nm)	16.1	3.37
EXAMPLE27	IrMn (5nm)	CoFe (0.5nm)	FeCo (0.9nm)	CoFe (0.5nm)	15.7	3.26
COMPARATIVE EXAMPLE11	IrMn (5nm)	CoFe (1.5nm)	—	—	16.0	3.23
COMPARATIVE EXAMPLE12	PtMn (13nm)	CoFe (1.5nm)	—	—	15.1	2.78

Fig.8

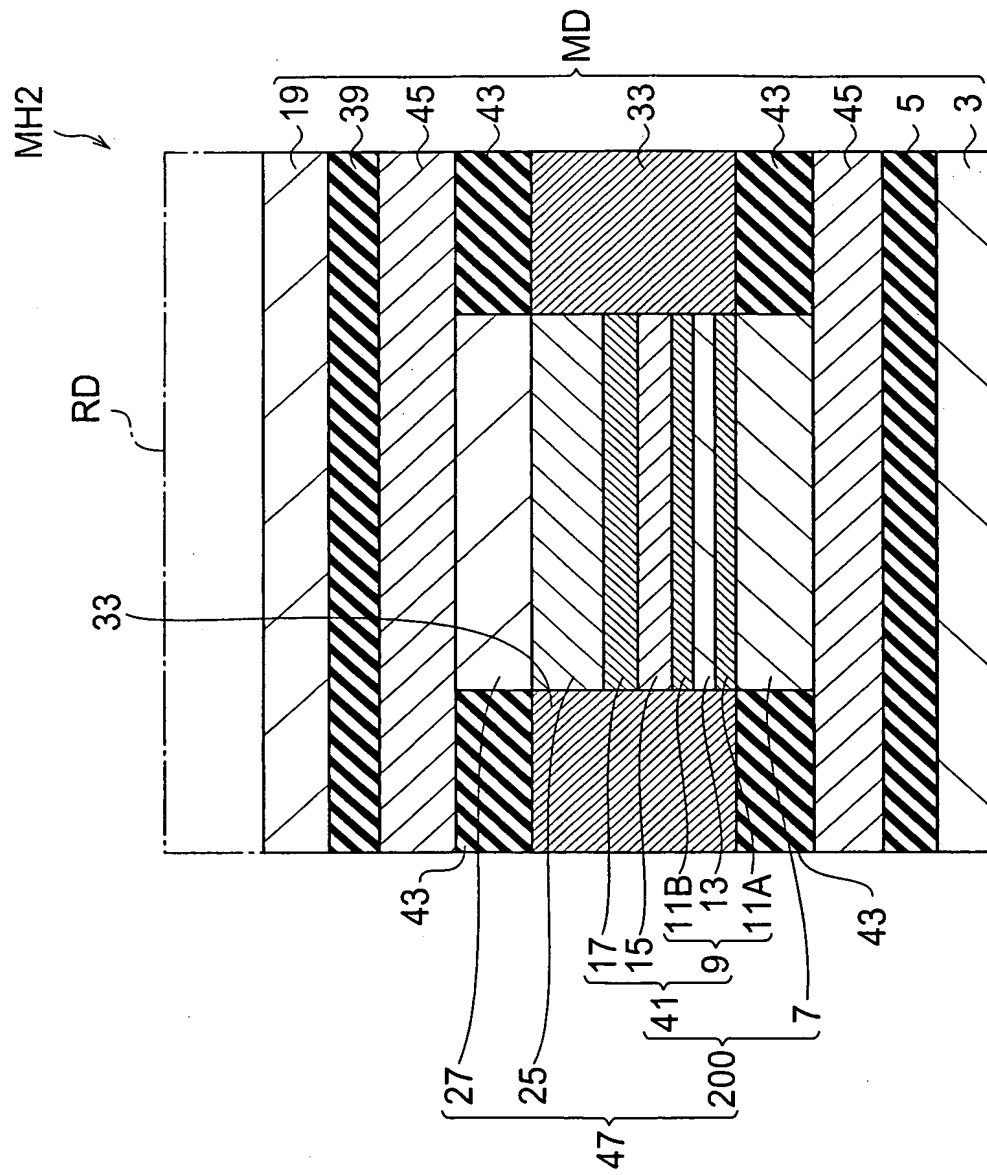


Fig. 9

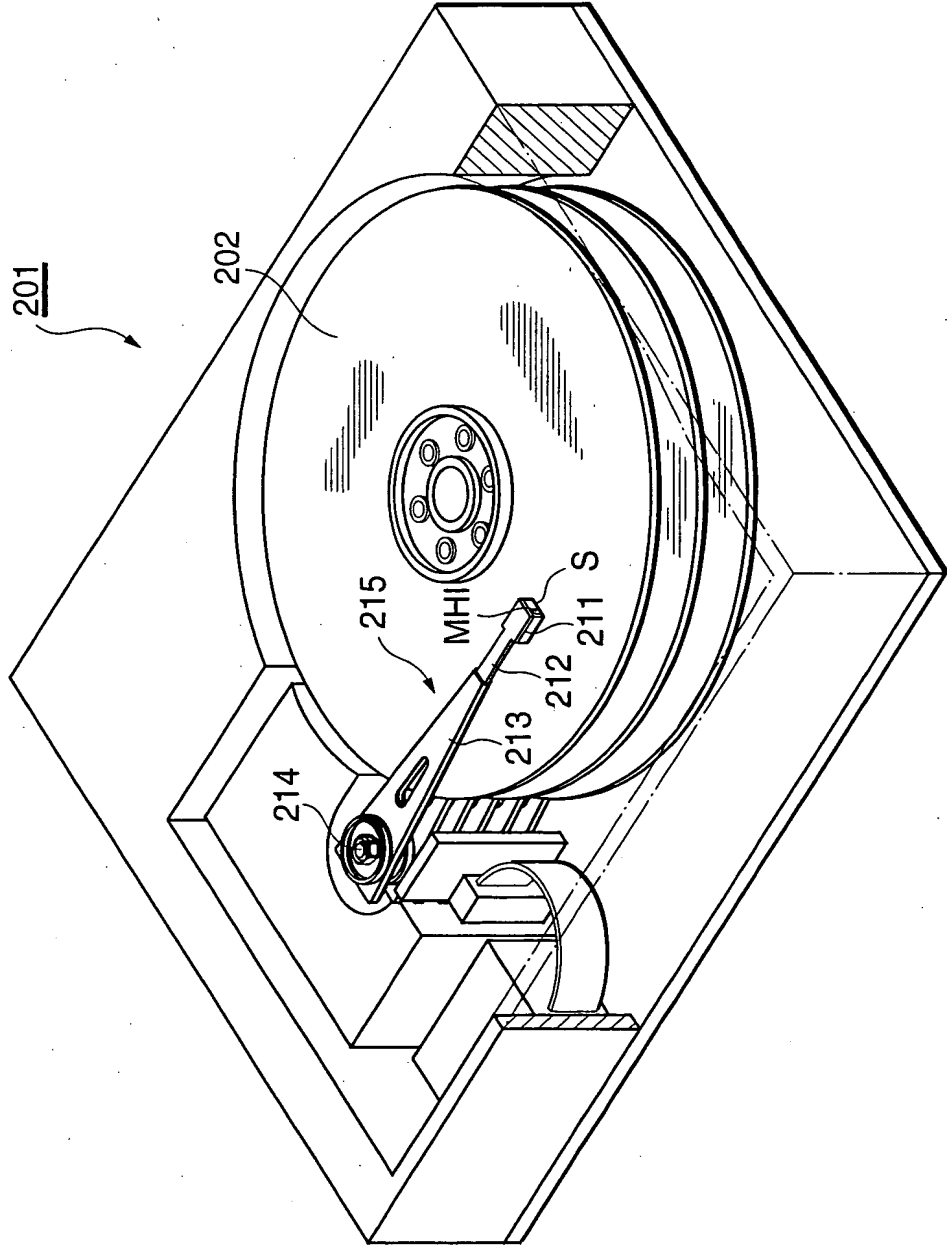


Fig.10

